

NEW SPECIES OF *SATHODRILUS* HOLT, 1968,  
(CLITELLATA: BRANCHIOBDELLIDA) FROM  
THE PACIFIC DRAINAGE OF THE  
UNITED STATES, WITH THE SYNONYMY OF  
*SATHODRILUS VIRGILIAE* HOLT, 1977

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*Abstract.*—Four new species of the genus *Sathodrilus* Holt, 1968, are diagnosed, described, illustrated, and their ranges given. *Sathodrilus virgiliae* Holt, 1977, is shown to be a junior subjective synonym of *Cambarrincola inversa* Ellis, 1919. *Sathodrilus lobatus* Holt, 1977, includes *Sathodrilus wardinus*, new species. Other new species treated are *S. attenuatus*, *S. chehalisae*, and *S. shastae*.

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Some years ago a report was published on members of the genus *Sathodrilus* Holt, 1968, from the Pacific Northwest of the United States (Holt, 1977). Since that work further new species have been recognized among the materials in the collections, and to present them and to reduce to synonymy a name (*Sathodrilus virgiliae*) proposed in the paper mentioned is the purpose of this report.

Methods of handling and presenting material have been recorded before (i.e., Holt, 1977:116). All measurements are given in millimeters with the extremes of a series enclosed in parentheses.

Holotypes are deposited in the collections of the National Museum of Natural History; all other specimens are in my collections at Virginia Polytechnic Institute and State University (identified with the initials "PCH"). Unless otherwise stated, all collections used were taken by Virgie F. Holt and me.

My thanks are due the National Science Foundation and Virginia Polytechnic Institute and State University for financial support; to my wife, Virgie F. Holt, for various types of assistance; to Dr. Horton H. Hobbs, Jr., for host identifications, reading the manuscript and over three decades of friendly encouragement.

*Sathodrilus* Holt, 1968

*Type-species.*—*Sathodrilus carolinensis*, by original designation.

*Diagnosis.*—See Holt, 1977:16-17.

*Sathodrilus attenuatus*, new species

Fig. 1

*Type-specimens*.—Holotype, USNM 65227, and 36 paratypes, PCH 1113, taken on *Pacifistacus* (*Pacifastacus*) *leniusculus klamathensis* (Stimpson, 1957) from Elk Creek, about 12.6 miles south of Cottage Grove, Douglas County, Oregon, 11 July 1960.

*Diagnosis*.—Slender, medium-sized worms (holotype 3.0 mm long); no dorsal ridges; lips entire; no oral papillae; jaws slight, subrectangular *en face* view, dental formula 4/4-(?) 5/4; bursa small, subspherical; spermiducal gland flexed, U-shaped, with prominent deferent lobes; prostate short, non-differentiated; spermatheca with long ectal duct, long clavate bulb, no ental process.

*Entymology*.—Latin, *thinned, stretched out*, in reference to the slender body of the animals.

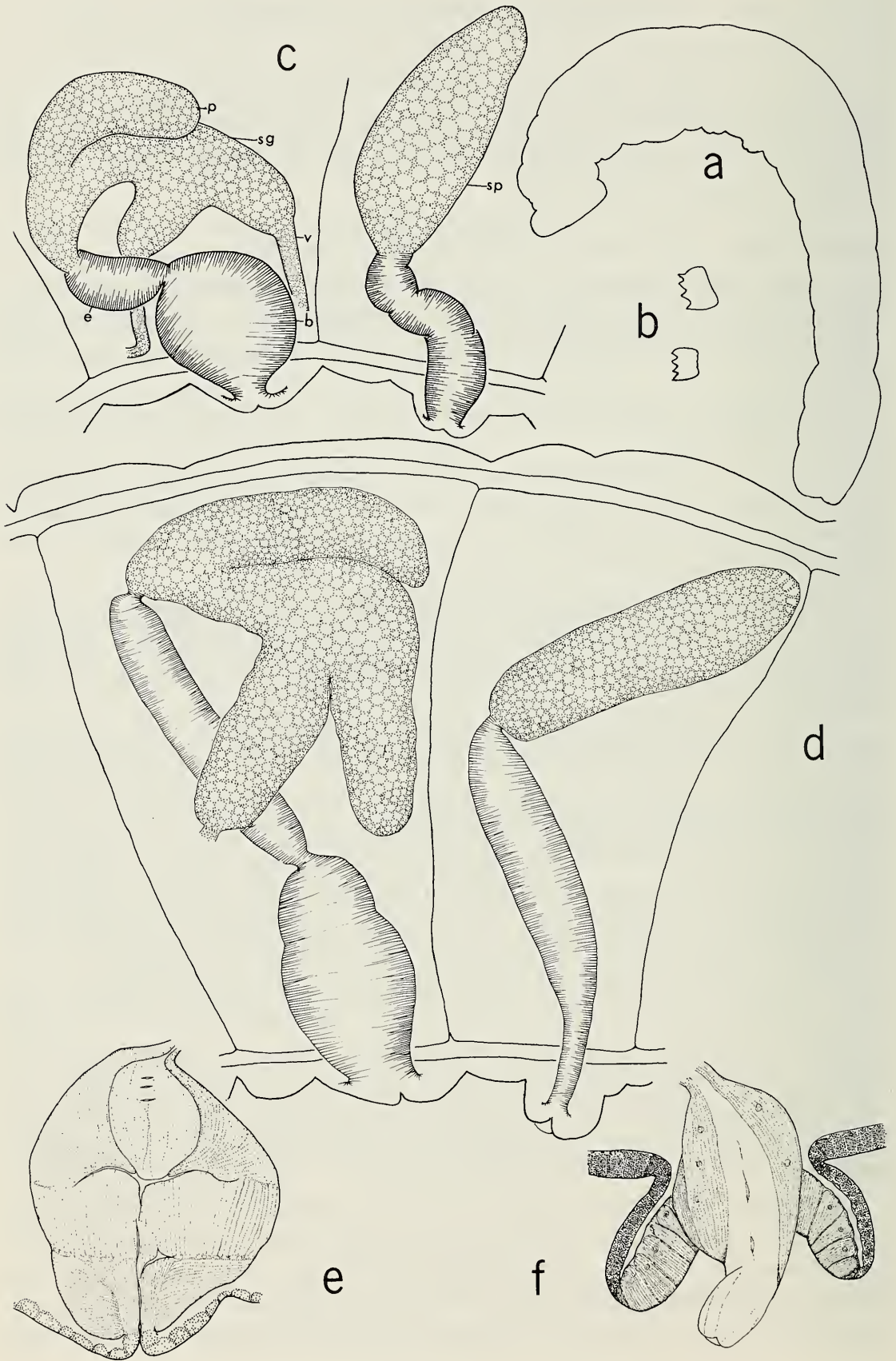
*Description*.—Members of *Sathodrilus attenuatus* are small to medium-sized worms of slender appearance, increasing from segment I gradually in diameter to the greatest thickness in segment VIII. The head, slightly greater in diameter than segment I, is also slender.

The holotype and 4 paratypes have the following dimensions: total length, 2.7 (2.2–3.1); greatest diameter, 0.4 (0.4–0.5); head length, 0.5 (0.4–0.5); head diameter, 0.2 (0.2–0.3); diameter, segment I, 0.2 (0.2–0.2); diameter, sucker, 0.3 (0.2–0.3).

The lips are entire, except for the lateral indentations that form them. There are no oral papillae. Dorsal ridges are absent and the body outline is consequently relatively smooth, though the sulci that demarcate the segments and posterior annuli of segments are usually distinct. The head is slender and tapers towards the mouth; the peristomial sulcus is shallow; an indistinct external sulcus of the head is present slightly anterior to the level of the single pharyngeal sulcus. The anterior nephridiopore is undetectable in well prepared whole mounts. The clitellum is thin, but distinct.

The jaws are proportionately small: of the usual triangular shape in lateral view; subrectangular *en face* view. They are light yellow. The dental formula is difficult to determine: the teeth are small and in some specimens a lateral tooth of the upper jaw is not easily seen, if indeed it is present, but the dental formula may be 5/4, though the paratype from which the jaws were drawn (Fig. 1) and most specimens in which the teeth can be counted appear to have only 4 teeth on the upper jaw.

The spermiducal gland is about  $\frac{2}{3}$  the body diameter in total length, but usually lies longitudinally in the coelom and its dorsal border reaches only a short distance beyond the mid-portion of the segment. Entally, the vasa deferentia widen to form 2 large and prominent deferent lobes; ectally, the spermiducal gland decreases in diameter towards its junction with the ejac-



ulatory duct. The prostate arises some distance entad to this junction, is non-differentiated, relatively short, ending entally at about the mid-length of the spermiducal gland and lacks an ental bulb.

The ejaculatory duct is thick with an expanded lumen. The subspherical bursa is small, its dorsal border hardly, if at all, extending beyond the ventral border of the gut; the retracted penis is about  $\frac{1}{3}$  of that of the bursa in length and relatively short in the everted position (Fig. 1f). The bursal atrium is filled with a thick atrial fold (Fig. 1e).

The spermatheca is not unusual. Its ectal duct is long and bent underneath the gut; the bulb is elongated, clavate to cylindrical, and extends approximately to the dorsal border of the gut. There is no ental process, but the wall of the ental end may be thickened (Fig. 1c).

*Variations.*—The uncertainty in the number of teeth borne by the upper jaw, reflecting a possibly real variation, has been mentioned. The prostate may lie in a plane different from that of the spermiducal gland, appearing to be a branch of the latter as in *S. inversus* (Holt, 1977:130). The bulb of the spermatheca is of irregular outline (“wrinkled”) in some specimens and has a rudimentary ental process (Fig. 1c) in others. The usual differences associated with position of structures and degree of contraction at death are apparent.

*Affinities.*—The closest relative of *S. attenuatus* is *S. inversus* (Ellis, 1912). The latter has a dorsal ridge on segment VIII, a dental formula of 5/4 with a triangular upper jaw; a larger spermiducal gland without deferent lobes; a longer bursa enclosing a longer, more membranous penis; and a thin-walled median portion of the spermatheca. (But compare *S. chehalisae* below.)

*Hosts.*—*Pacifastacus (P.) leniusculus leniusculus* (Dana, 1852), *P. l. klamathensis*.

*Distribution.*—Streams of the Cascade and Coastal Ranges in Oregon and Washington to the headwater streams of the Snake River in Wyoming.

*Material examined.*—OREGON: 3 specimens, PCH 1111, taken on *P. l. klamathensis* from Myrtle Creek, 1.2 miles west of Tiller, Douglas County, 11 July 1960; 9 specimens, PCH 1112, taken on *P. l. klamathensis* from North Fork of Umpqua River at Winchester, Douglas County, 11 July 1960; type-series; 13 specimens, PCH 1114, taken on *P. l. klamathensis* from Row

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Fig. 1. *Sathodrilus attenuatus*: a, Lateral view of holotype; b, *En face* view of jaws of a paratype; c, Lateral view of reproductive systems of holotype (b, bursa; e, ejaculatory duct; p, prostate; sg, spermiducal gland; sp, spermatheca; v, vas deferens); d, Lateral view of reproductive systems of specimen from Yakima County, Washington; e, Optical section through bursa and penis of a paratype; f, Optical section of everted bursa and penis of a specimen from Yakima County, Washington.

River, 2.0 miles east of Cottage Grove, Lane County, 11 July 1960; 6 specimens, PCH 1117, taken on *P. l. leniusculus* from Mary's River, 4.8 miles southeast of Blodgett, Benton County, 12 July 1960; 2 specimens, PCH 1119, taken on *P. l. klamathensis* from a small stream, 14.4 miles east of Toledo, Lincoln County, 12 July 1960; 9 specimens, PCH 1121, taken on *P. l. leniusculus* from Siletz River, 24.3 miles southeast of Kernville, Lincoln County, 12 July 1960; 12 specimens, PCH 1124, taken on *P. l. klamathensis* from South Yamhill River, 1.6 miles west of Valley Junction, Polk County, 13 July 1960; 2 specimens, PCH 1126, taken on *P. l. klamathensis* from Little Pudding Creek, 7.9 miles southwest of Silverton, Marion County, 13 July 1960. WASHINGTON: 5 specimens, PCH 1120, taken on *P. l. klamathensis* from Gray's River, 21.0 miles east of Gray's River, Wahkiakum County, 14 July 1960; 4 specimens, PCH 1133, taken on *P. l. klamathensis* from Humptulips River at Humptulips, Gray's Harbor County, 16 July 1960.

*Remarks.*—I have 5 specimens, PCH 1501, taken on *Pacifastacus gambelli* (Girard, 1852) from Crawfish Creek at the base of Moose Falls, Yellowstone National Park, Wyoming, summer 1961, by R. C. Powell, that differ from those of *S. attenuatus* in being somewhat shorter and more corpulent in appearance, with more prominent external sulci of the head and an additional internal sulcus that is probably the result of a greater degree of contraction. Internally, the ejaculatory duct of the Yellowstone specimens appears to be longer than that of *S. attenuatus* and there is possibly an ental bulb of the prostate. The jaws of these specimens are difficult to interpret; they may be triangular *en face* view with a 1/2 or 3/4 dental formula.

Four specimens, PCH 1811, taken on *Pacifastacus (P.) l. klamathensis* from the Naches River at the confluence of the Naches and Tieton Rivers, Yakima County, Washington, 13 August 1964, were also thought at first to represent a new species. The spermatheca of one of these specimens has an exceedingly long ectal duct and is set off from the spermathecal bulb by a constriction. The ejaculatory duct is long and there is no ental bulb of the prostate. The apparent differences in the reproductive systems of the members of these populations from those of *S. attenuatus* are subtle (Fig. 1c, d) and until additional material is available they are best regarded as possibly geographical variants, but more likely further study will reveal that the apparent differences are intra-populational throughout the range of the species.

*Note.*—This species was omitted from the earlier account (Holt, 1977) because in my initial studies of the material collected in 1960 I assigned the species to the genus *Cambarincola*. As the years passed, the concepts of the genera *Sathodrilus* and *Cambarincola* have been refined and *attenuatus* must be placed in *Sathodrilus* as the genus is now understood. There are

many congeners native to other areas of the species treated herein and the limits of the genera concerned may shift as these species are accorded proper treatment.

*Sathodrilus chehalisae*, new species

Fig. 2a-c

*Type-specimens*.—Holotype and 7 paratypes, USNM 65228; 4 paratypes, 1 serially sectioned, PCH 1813, taken on *Pacifastacus (P.) leniusculus trowbridgii* (Stimpson, 1857) from Chehalis River at Adna, Lewis County, Washington, 15 August 1964.

*Diagnosis*.—Small worms (holotype 1.8 mm in length); no dorsal ridges; head without external sulci, except peristomial one; upper lip with 4 short, blunt lobes, lower (?) entire; no oral papillae; one internal pharyngeal sulcus; jaws small, medium dark brown, dental formula 3/2; bursa small, subglobose, about  $\frac{1}{3}$  body diameter in length, penial sheath about  $\frac{1}{2}$  total bursal length; spermiducal gland less than body diameter in length, without deferent lobes; prostate about  $\frac{2}{3}$  spermiducal gland in length, subequal to latter in diameter, with indistinct ental bulb; spermatheca greater than body diameter in length, spermathecal bulb elongate clavate, about  $\frac{2}{3}$  of total organ in length, with obscure short ental process.

*Etymology*.—For the Chehalis River.

*Description*.—The average dimensions of the holotype and 4 paratypes of *S. chehalisae* are as follows: total length, 1.8 (1.7–2.1); greatest diameter, 0.3 (0.2–0.3); head length, 0.3 (0.3–0.3); head diameter, 0.2 (0.2–0.2); diameter, segment I, 0.2 (0.2–0.2); diameter, sucker, 0.2 (0.1–0.3).

The anterior annuli of the body segments are slightly greater in diameter than the posterior ones, but the supernumerary muscles of these annuli are very slight and difficult to detect in intact specimens. The clitellum is not prominent; the anterior nephridiopore is undetectable in material mounted entire. The upper lip bears 4 short, blunt lobes that are easily overlooked, the lower has no detectable lobes and the peristomium as a whole is often slightly expanded (campanulate). There are no external sulci of the head, except the peristomial one.

There are no oral papillae. The jaws are triangulate, medium brown in color and relatively small; bearing on the upper one a prominent median tooth and 2 obscure lateral teeth, on the lower 2 distinct paramedian teeth.

The spermiducal gland is of modest proportions and lacks deferent lobes. The prostate arises at about the level of the ectal third of the spermiducal gland, is subequal to the latter in diameter, non-differentiated, and ends entally in an obscure ental bulb at the level of the ental end of the spermiducal gland.

The ejaculatory duct is a relatively long slender tube without any distinctive features and is difficult to distinguish in animals mounted entire.

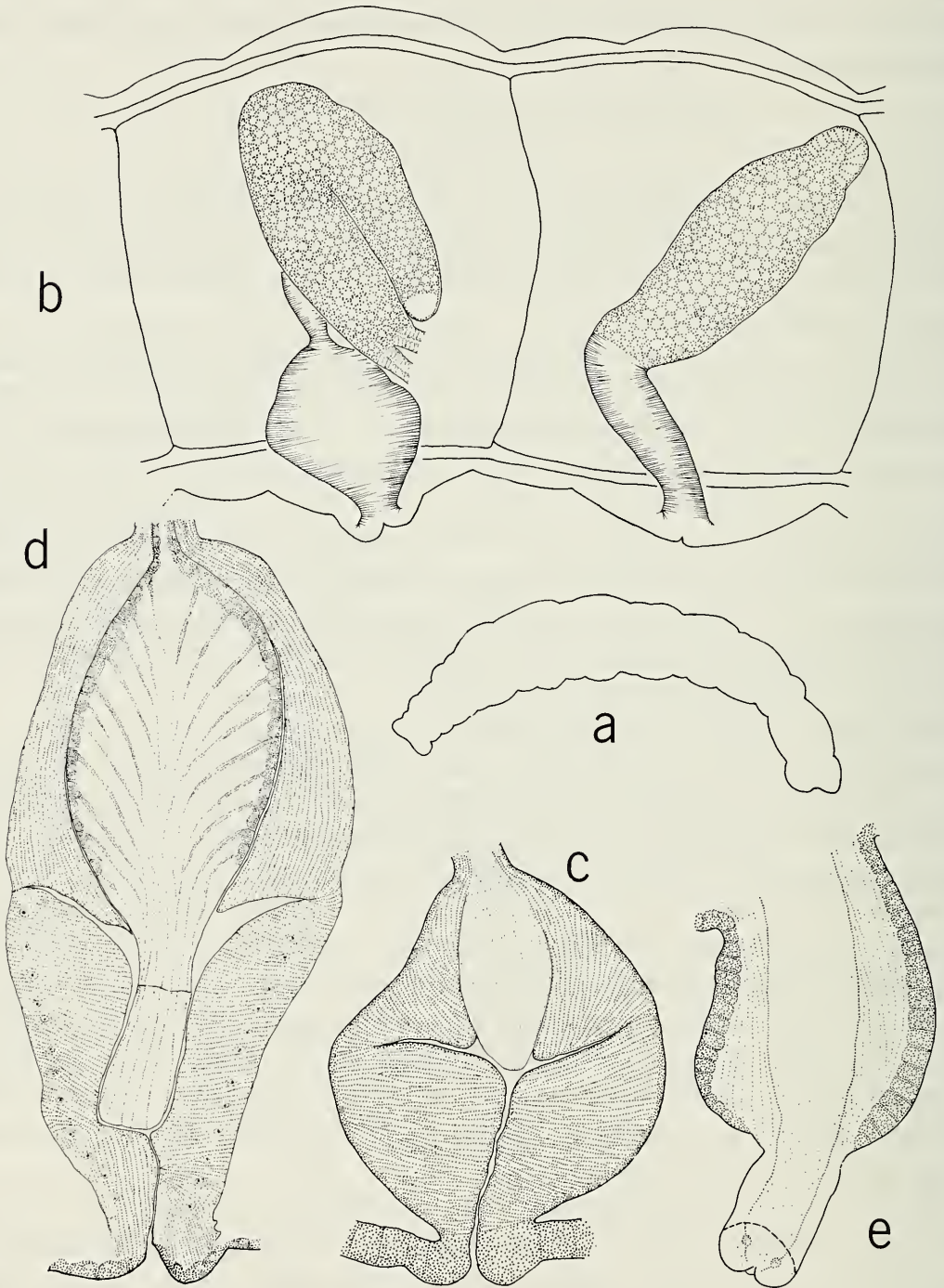


Fig. 2. *Sathodrilus chehalisae*: a, Lateral view of holotype; b, Lateral view of reproductive systems of holotype; c, Optical section of bursa and penis. *Sathodrilus inversus*: d, Optical section of bursa and penis of specimen from Yakima County, Washington; e, Optical section of everted bursa and penis of specimen from Benton County, Oregon.

The atrial region composes most of the bursa; the penial sheath is a thin layer of muscle composing the ental end of the bursa and enclosing a short, but distinctly membranous, penis (Fig. 2c).

The spermatheca is composed of a relatively long, slender ectal duct, an elongate bulb and an obscure ental bulb. The spermathecal bulb is inclined anteriorly and its wall, variously "twisted" or wrinkled, is composed of the usual thin epithelial layer. The ental process of the organ is less in diameter than the bulb, relatively short and composed of a layer of taller epithelial cells.

*Variations.*—The number of teeth borne by the jaws is somewhat uncertain, though confirmed by the number in a specimen sectioned transversely: in immature animals the dental formula may be 5/4. Otherwise, no variations other than the usual ones of different degrees of contraction at death were noted.

*Affinities.*—*Sathodrilus chehalisae* has the general facies of *S. inversus*: the two species are closely related in the sense of being of similar appearance; indeed, specimens of *S. chehalisae* were passed by at first as specimens of the latter. The lips of *S. chehalisae* are more often expanded than those of *S. inversus* and its jaws are darker and somewhat larger. There is no detectable dorsal ridge of segment VIII in *S. chehalisae*. The spermiducal gland of the latter is proportionately smaller and its prostate is adherent to the spermiducal gland and has an indistinct prostatic bulb. The bursa of *S. chehalisae* is smaller (? shorter) and the ejaculatory duct, though not of uniform diameter throughout, lacks a distinct median expansion. *S. attenuatus*, another close relative of *S. chehalisae*, differs, among other features, in jaw structure and the absence of a prostatic bulb.

*Host.*—*Pacifastacus (P.) leniusculus trowbridgii*.

*Material examined.*—The type-series.

*Sathodrilus inversus* (Ellis, 1919), new combination

Fig. 2d, e

*Cambarincola inversa* Ellis, 1919:259–260.

? *inversa*, Hoffman, 1963:294.

*Sathodrilus virgiliae* Holt, 1977:128–131.

*Type-specimens.*—USNM 16780, Eugene, Oregon, taken on *Astacus* [= *Pacifastacus*] *klamathensis* by J. E. Gutberlet (from Ellis, 1919:259); paratypes: "Five, Cat. No. 17680, U.S.N.M., and 15 others collected with the type" (Ellis, 1919:259).

*Diagnosis.*—"Small slender worms . . . ; body outline smooth, segment VIII [often] with obscure dorsal ridge with minute supernumerary muscles; upper lip with 4 short lobes, lower lip entire; no oral papillae; jaws small, light brown, dental formula 5/4; bursa long, cylindrical, slightly greater than



$\frac{2}{3}$  body diameter in length, penial sheath about  $\frac{1}{2}$  total bursal length; spermiducal gland large, approximately twice the body diameter in length; prostate about  $\frac{1}{2}$  spermiducal gland in length, usually not adherent to latter; spermatheca with long ectal duct; long spermathecal bulb, no ental process'' (Holt, 1977:128).

*Remarks.*—Hoffman (1963:294), working in my laboratory, recognized that Ellis's species *inversa* was not a member of the genus *Cambarincola* and promised with my concurrence that I would erect a new genus for it. In the interval extending over about 14 years between his work and my paper (Holt, 1977) describing species of the genus *Sathodrilus* from the Pacific Northwest, this promise was forgotten. It was only after my paper was printed that I remembered I had not seen specimens of Ellis's species again in my collections: specimens that both Hoffman and I had compared with the types. The types were again sent me from the National Museum of Natural History and as I feared *S. virgiliae* is a junior subjective synonym of *inversus*. Hoffman's promise has been kept and my gross error corrected.

Ellis (1919:259) only illustrated the jaws of *S. inversus*. These illustrations and his description fit my specimens and agree with my shorter independent account. The number of teeth are variable, as Ellis maintained. His discussion of the size and shape of the body accords well with mine. His report also includes non-diagnostic comments about the gut and the statement that the spermatheca is "simple, long, and tubular . . ." The dorsal ridge on segment VIII (Holt, 1977:130) was not noticed by Ellis and is often obscure.

*Material examined* (additions to the previous records (Holt, 1977:131)).—OREGON: 1 specimen, PCH 1117, taken on *P. (P.) l. leniusculus* from Mary's River, 4.8 miles east of Blodgett, Benton County, 12 July 1960. WASHINGTON: 15 specimens, PCH 1142, taken from a small stream, 7.2 miles east of Ellensburg, Kittitas County, 18 July 1960; 10 specimens, PCH 1811, taken on *P. (P.) l. klamathensis* from Naches River, 5.0 miles northwest of Naches, Yakima County, 13 August 1964; 8 specimens, PCH 1812, taken on *P. (P.) l. klamathensis* from the outflow of Lake Kachess, about 16 miles west of Cle Elum, Kittitas County, 13 August 1964.

Drawings (Figs. 2d, e) of optical sections of the penes of two specimens are included in this account for comparison with similar illustrations for other species. Compare, for instance, the corresponding illustrations for *S. attenuatus* (Figs. 1e, f) above.

### *Sathodrilus shastae*, new species

Fig. 3a–e

*Type-specimens.*—Holotype, USNM 65230, and 4 paratypes, PCH 1818, taken on *Pacifastacus (Hobbsastacus) fortis* (Faxon, 1914) from the headwaters of Fall River, Thousand Springs Ranch, Shasta County, California, 19 August 1964.

*Diagnosis.*—Medium-sized worms (holotype 3.8 mm in length); lips entire; no oral papillae; no dorsal ridges; dental formula 1/1; bursa elongate, fusiform; penial sheath not externally delimited, about  $\frac{1}{2}$  bursa in length; penis membranous tube, lying partially free in bursal atrium; ejaculatory duct long, thick; spermiducal gland slender, long, exceeding twice body diameter in length, with anterior deferent lobe, no prostate; spermatheca spatulate with short ectal duct, obscure ental process.

*Etymology.*—For Mount Shasta. The type-locality is a spring fed by the melting of snow on Mount Shasta and issues through the lava debris at the foot of the mountain.

*Description.*—*Sathodrillus shastae* is composed of medium-sized worms. The holotype and 4 paratypes have the following dimensions: total length 3.8 (3.5–4.4); greatest diameter, 0.8 (0.5–0.8); head length 0.7 (0.6–0.9); head diameter 0.5 (0.4–0.7); diameter, segment I, 0.5 (0.4–0.6); diameter, sucker, 0.5 (0.4–0.7).

The lips are entire and there are no oral papillae. Other than the peristomial one, there is a very shallow external sulcus of the head at the level of the posterior of the 2 pharyngeal sulci. There are no dorsal ridges. The clitellum is not unusual.

The jaws are prominent, triangular *en face* view and bear one prominent tooth each at the apex. Slight undulations of the jaws may give the impression of lateral teeth, but none could be unambiguously found.

The spermiducal gland is remarkably long, approximately twice the diameter of segment VI, and relatively slender. The posterior vas deferens enters the gland somewhat ectad of its ental end, thereby producing a short, but prominent anterior deferent lobe. There is no evidence of a prostate or prostatic protuberance.

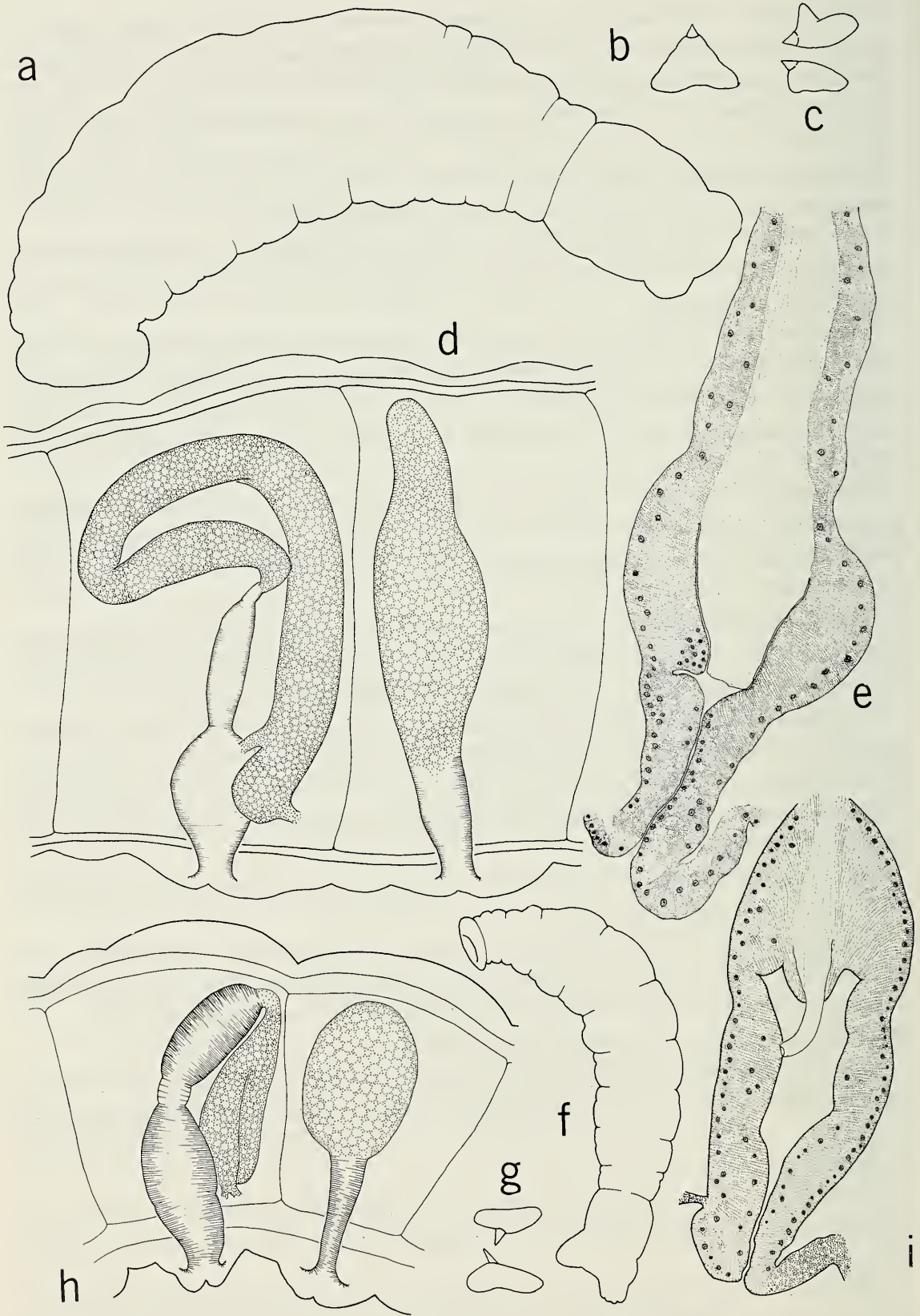
The ejaculatory duct is of medium proportionate length and is notably muscular and thick.

The atrial region of the bursa is reduced, appearing as the ectal outlet duct of the organ. The penial sheath is greater in diameter than the ectal portion of the bursa and subequal in length. The penis projects into a reduced atrial cavity as a membranous tube.

The spermatheca is composed of a relatively short ectal duct, a fusiform bulb which is clearly seen in serial sections as flattened between the gut and body wall, and a narrow ental portion which extends dorsad of the gut as an obscure ental process.

*Variations.*—None of note in the available material. As is usual the spermiducal gland and spermatheca may assume slightly different positions within the coelom.

*Affinities.*—The relatives of *S. shastae* must be sought among its congeners without prostates and all of these are found in regions remote from northern California. *S. norbyi* from the Snake River drainage is a much smaller worm with a minute prostate or prostatic protuberance and is oth-



erwise rather unlike *S. shastae*. Other members of the genus from the Pacific Northwest have patent prostates and in various ways each is quite unlike *S. shastae* (Holt, 1977:120–131).

Among the species without prostates or prostatic protuberances, *S. verrucosus* Holt, 1968, is Mexican, and *S. hortonii* (Holt, 1973) and *S. oka-loosae* are from Florida. These three species are all small worms, about  $\frac{1}{2}$  the size of *S. shastae*, have dental formulae of  $\frac{5}{4}$  or  $\frac{1}{4}$ , with jaws very much unlike those of *S. shastae* which resemble those of some species of *Cambarincola*. They also differ in various features of the spermathecae and the proportions of the male efferent apparatus.

*Sathodrilus megadenus* Holt, 1968, from Haralson County, Georgia, is of approximately the same size with approximately the same exterior appearance as *S. shastae*, but differs in several respects: there is small prostatic protuberance borne on the long spermiducal gland which lacks deferent lobes; the bursa is proportionately larger; the spermatheca has a much more pronounced ental process (Holt, 1968:302–305). As noted before, the determination of true (phylogenetic) relationships of branchiobdellids at this stage of our knowledge of them is uncertain at best.

*Host*.—*Pacifastacus* (*H.*) *fortis*.

*Material examined*.—The type-series and an animal serially sectioned.

*Sathodrilus wardinus*, new species

Fig. 3f–i

*Sathodrilus lobatus* Holt, 1977 (in part).

*Type-specimens*.—Holotype and one paratype, USNM 65229; 5 paratypes, PCH 921, taken on *Pacifastacus* (*P.*) *leniusculus klamathensis* from Purdy Creek, 6.0 miles north of Gig Harbor, Pierce County, Washington, by Darwin E. Norby, 26 June 1959.

*Diagnosis*.—Small worms; body outline smooth; peristomium campanulate, upper lip with 6, lower with 2 lobes, laterally 4 lobes; no oral papillae; jaws small, dark brown, dental formula  $\frac{3}{2}$ ; bursa cylindrical, slender, about  $\frac{1}{2}$  body diameter in length, penial sheath about  $\frac{2}{3}$  of bursal length; ejaculatory duct subequal to bursa in diameter; spermiducal gland slender, about  $\frac{2}{3}$  body diameter in length; prostate subequal to spermiducal gland in di-

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Fig. 3. *Sathodrilus shastae*: a, Lateral view of holotype; b, *En face* view of upper jaw of a paratype; c, Lateral view of jaws of a paratype; d, Lateral view of reproductive systems of holotype; e, Median section of bursa, penis, and ental end of ejaculatory duct of a paratype. *Sathodrilus wardinus*; f–h, holotype: f, Lateral view of entire animal; g, Lateral view of jaws; h, Lateral view of reproductive systems. i, Specimen from Pierce County, Washington, median section of bursa and penis.

ameter, about  $\frac{2}{3}$  length of latter; spermatheca with long, narrow ectal duct subglobose bulb, no ental process.

*Etymology.*—An anagram; perhaps best regarded as an arbitrary combination of letters.

*Description.*—Small worms, the holotype is about 2.0 mm in length; it and 4 paratypes have the following dimensions: total length, 2.0 (1.8–2.2); greatest diameter, 0.4 (0.3–0.4); head length, 0.4 (0.4–0.5); head diameter, 0.2 (0.2–0.3); diameter, segment I, 0.2 (0.2–0.3); diameter, sucker, 0.2 (0.2–0.3).

The body outline is smooth. Though the major annulation of segment VIII is noticeably, though not greatly raised, there are no supernumerary muscles present. There is a single external sulcus of the head at about the level of the single pharyngeal one, but it is very shallow and often not readily noticed. The peristomium is flared, campanulate, often much more than in the holotype. The upper lip bears 4 blunt lobes, the lower 2, and 2 lateral lobes are usually apparent on each side. Oral papillae are absent. The jaws are small and dark and it is difficult to determine the dentition in most specimens mounted entire, but in one sub-mature animal the jaws are light in color and the teeth clearly seen: the dental formula is  $3/2$ .

The spermiducal gland is distinctive. In length it is subequal to the coelom in which it lies, about  $\frac{2}{3}$  the total diameter of segment VI. Throughout rather slender, it is rounded at the point of entry of the vasa deferentia, expands slightly and tapers to a narrow, obscure tube at its junction with the ejaculatory duct. The ental end of the prostate is marked by a small, clear prostatic bulb and reaches the ental end of the spermiducal gland to which it closely adheres. The prostate is about  $\frac{1}{3}$  the length and diameter of the spermiducal gland.

The ejaculatory duct is a thick muscular tube except at the constrictions at its junctions with the spermiducal gland and the penial sheath of the bursa. The duct itself is composed of an outer epithelial layer, a thick layer of muscle fibers oriented lengthwise of the duct and an inner epithelium, presenting in sections a noticeable resemblance to the structure of the penial sheath.

The penial sheath is more than  $\frac{1}{2}$  the total length of the bursa in length and the bursa as a whole is rather slender,  $\frac{3}{8}$  its own length in diameter, and elongated, approaching  $\frac{1}{2}$  the body diameter in length. The atrium of the bursa is expanded and the penis projects into it as a slender, membranous tube.

The spermatheca consists of a long, slender ectal duct and an expanded, ovoid bulb, without any evidence of an ental process.

*Variations.*—In some specimens from Minter Creek, Pierce County, Washington, the spermathecal bulb is not expanded and appears as a thick walled, closed entally, tube. No other variations, other than the usual ones

of size, degrees of contraction and slight variations in position of the reproductive organs were noted.

*Affinities.*—*Sathodrilus wardinus* is superficially remarkably similar to *S. lobatus* Holt, 1977, and, without a careful study of the reproductive systems, is easily confused with the latter. The campanulate and extensively lobed peristomia of both species present almost identical appearances. They differ in the number of lobes: 6 dorsal, 3 lateral on each side and 2 ventral for a total of 14 in *S. lobatus*; while *S. wardinus* is furnished with only 4 dorsal lobes, 2 lateral ones on each side and 2 ventral ones for a total of 10. The jaws of the two species are similar, but apparently differ in the number of teeth they bear: the dental formula of *S. wardinus* is questionably  $3/4$ ; that of *S. lobatus*,  $5/4$ . The spermiducal gland of *S. wardinus* is smaller and shorter and the spermatheca is of the common pattern of ectal duct and expanded bulb, while the spermatheca of *S. lobatus* is distinctive with a long and thick ectal duct, a fluid filled expanded median portion and a long, slender "ental process" always filled with spermatozoa.

*Hosts.*—*Pacifastacus* (*P.*) *leniusculus klamathensis*; *P.* (*P.*) *l. trowbridgii*.

*Distribution.*—*Sathodrilus wardinus* is known only from two locations in Pierce County, Washington, among the eastern foothills of the Olympic Mountains. *S. lobatus* is common on the Olympic Peninsula and the two very similar species may be sympatric.

*Material examined.*—The type-series; 8 specimens, PCH 923, mounted entire 2 serially sectioned ones; typotypes, taken by Darwin E. Norby, 13 July 1959; 3 specimens, PCH 1139, taken on *P.* (*P.*) *l. trowbridgii* from Minter Creek, 3.8 miles west of Wauna, Pierce County, Washington, 17 July 1960 (assigned to *S. lobatus* Holt, 1977:125).

### Note

This is the eighth and possibly the last of a series of papers on the branchiobdellids of the Pacific Drainage of the Northwestern United States. There remain in my collections some scattered materials, some perhaps "lost" in the collections, but mostly that sent to me by students of crayfish. Among these people I want to especially thank Mr. William H. Clark for his efforts, though most of his material is unidentifiable. (Students of fishes and crayfishes tend to collect their material in poor fixatives—for branchiobdellids—and to overfill their collecting bottles. I regret this.)

There are other single specimens, identified in the collections, that I have chosen to omit. Perhaps later I can bring all of these materials together, though I know that the materials on which all these reports are based are but a random sample of the branchiobdellid fauna of the Pacific Drainage.

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